Trends and Models in the Consumption of Electronic Contents
An Analysis of the Journals Most Widely Used in Spanish Universities

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The study is focused on the changes in the consumption of electronic information by the academic communities of five Spanish universities through the contents distributed by four widely used suppliers, from the very first subscription to them down to 2010. Similarly, the preferences of these institutions for titles distributed by the suppliers under consideration and their links to various different academic fields were investigated. From 24% to 30% of the overall total of downloads came from the top 25 favourite titles of the respective academic communities. This fact points to a need to go beyond the Big Deal model and strive for greater flexibility in subscriptions to resources, so as to have made-to-measure supplies.

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Introduction

The work being presented here is the outcome of a line of research begun in 2004[1] intended to investigate the supply and use of electronic journals incorporated into university libraries as part of a package subscribed to under the *Big Deal* model.

Initially, the focus was on an analysis of what contents were accessible under the licences acquired, how many publications, topics covered, extent of digitising contents and size of backfiles. Attention was also paid to technical and functional aspects of the principal distributors of electronic materials, since these to a large degree shape their use[2–5].

The study was continued in 2006[6], directing attention towards an investigation of the consumption of electronic information. This line of research was based on an exploration of the downloading of articles, using the statistics that suppliers provide to libraries.

It would appear to be confirmed by the pioneering work of Tenopir and King[7], based on surveys of American academics, that researchers not only read more articles than formerly, but also look at items from a wider range of titles. Investigations into statistics of use corroborate the flexibility demanded by users and the benefits afforded by the *Big Deal* model, which permits much greater dispersion of consumption. It is true that more titles are used than those which were previously subscribed to in paper format. However, the bulk of downloads are taken from a limited percentage of titles. Thus, there is considerable concentration in usage, observed from the very beginning of the use of electronic journals in studies undertaken by Eason, Richardson and Yu[8] and Davis[9], as also in the more recent work noted above, done by the group responsible for this present paper. This tendency has also been confirmed by the investigations of Nicholas and the CIBER research group, who state that the majority of users limit themselves to exploring between one and three journals[10].

With regard to the frequency of use observed, Davis and Solla[11] remarked that the majority of users download one or two articles every three months. Nonetheless, they also recognise that a small group of dedicated users can skew the statistics, and that the data can be skewed because of downloads that students may carry out in order to prepare some piece of work set for them.

Studies relying on statistical data, like the present paper, do face certain limitations. Chief among these is the fact that it is debatable whether a download actually equates to reading in 100% of cases, thus whether downloads unequivocally imply consumption. Hence, it is wise to be cautious when drawing conclusions. As Nicholas et al.[12] pointed out downloads mean access, not use.

Nicholas[13] himself stated that there is no evidence on this point to show that all the documents downloaded do indeed get read. Researchers consult and download more documents than previously in an attempt to cover a similar range of information to what they had to hand before being able to access packages of electronic contents. However, the time available for reading cannot be indefinitely prolonged. On this point, it has been observed that less time is spent than before on reading each article and that people tend to read in full only articles of shorter length; if they are longer, people read just the abstract[14].

In recent years, consideration of the statistical data provided by editors has been supplemented by studies of user behaviour, involving analysis of log files and of data gathered in surveys. The intention has been to investigate the way in which electronic journals are accessed, reading habits and the purpose for which contents are used. This is achieved either by monitoring the steps taken by academics or by asking them directly, since, as Town[15] notes, counting was said to be no substitute for listening.

Nicholas et al.[16] indicate that researchers frequently read as a result of the activity of searching, rather than searching in order to read. This declaration points to a predominance of navigating over searching. However, on this point there is no unanimity. The *SuperJournal Project*[17] did show that researchers preferred to browse through contents. Nevertheless, this situation seems to have changed over time, as confirmed by other studies based on analysis of log files[18] and the results of various investigations founded on surveys, illustrating a tendency among the users of electronic journals to search rather than to browse[19–22]. As pointed out by Nicholas et al.[23] these discrepancies in results may be due to the fact that users behave differently as a function of their aims. They might use browsing to ensure keeping up to date with new work published, and searching to gather information on a specific theme.

The objectives of the work presented here reflect an attempt to gain knowledge of the changes in models of consumption of electronic information, to enquire which titles were preferred by scholars in five Spanish universities, and to identify the academic areas most active in the use of electronic journals. It is generally thought that researchers in sciences are those who make most use of electronic publications. Early investigations pointed to academics in the physics, biology and biomedical fields as being those who used electronic journals to the greatest extent[24–26]. More recent studies have confirmed these findings. Research by Tenopir et al.[27] highlighted the fact that the principal users of electronic journals were scholars in the exact and natural sciences.

Similarly, the work being reported here was intended to investigate the correspondence between the titles most often consulted and those to which there had been previous subscriptions in paper format, as well as the relationship between the use of certain journals and their prestige, using as indicators the *Journal Citation Report* (JCR) and the *Scimago Journal Report* (SJR). Patterns of behaviour common to the various different institutions were to be observed and individualised profiles were to be identified.

Objectives and Methodology

The overall aim of this study was to gain knowledge of the changes in the consumption of electronic information by the academic communities of five Spanish universities through the contents distributed by four widely used suppliers, from the very first subscription to them down to 2010. Similarly, the most downloaded titles of these institutions distributed by the suppliers under consideration and their links to various different academic fields were to be investigated. Specifically, the use made of journals to which subscriptions were held in packages from Emerald, ScienceDirect, SpringerLink and Wiley at the universities of Burgos, Leon, Salamanca, Valladolid and Vigo was to be studied. The first four of these universities belong to the Castile and Leon Autonomous Region and form the BUCLE consortium. The University of Vigo lies within the Autonomous Region of Galicia and is part of the Bugalicia consortium.

These institutions vary considerably in size and staff–student size ratios are proportional in all the universities investigated[28,29]. The University of Burgos is the smallest institution, with over 7000 students, and is followed in size by the University of Leon, with over 11,000. The other two universities in the Castile and Leon region have more than 25,000 students each, with the University of Vigo coming close to this size, having over 20,000 students.

It was noted that between 2005 and 2009 all five universities had a virtually unchanging total of teaching and research staff, the exception being the University of Salamanca, where there was a slight growth in academic staff. In respect of student numbers, a significant decrease was to be seen.

Table 1 shows the number of degree programmes offered by each university, subdivided into the five main areas of education, as also the percentage of the total courses available.

The field with the largest presence among the degree programmes offered by the group of universities under consideration was the area of social sciences, followed by the block bringing together technical degrees.

The specific aims pursued in this work were the following:

- To evaluate developments in the use of electronic information over the first decade of the twenty-first century.
- To analyse the concentration and/or dispersion of the use of electronic contents.
- To investigate the priorities of the various universities concerned, evaluating the differences in the use made of electronic contents by five universities in north-western Spain.
- To draw conclusions related to the relevance of the four packages of e-journals that are most widely used.

Table 1

Programmes offered

University	Humanities		Social Sciences		Experimental Sciences		Health Sciences		Technological Subjects	
	Degrees	Percent	Degrees	Percent	Degrees	Percent	Degrees	Percent	Degrees	Percent
Burgos	1	3.33%	15	50%	2	6.67%	1	3.33%	11	36.67%
Leon	6	11.11%	21	38.89%	4	7.41%	7	12.96%	16	29.63%
Salamanca	21	26.58%	24	30.38%	9	11.39%	6	7.59%	19	24.05%
Valladolid	12	12.90%	41	44.09%	8	8.60%	5	5.38%	27	29.03%
Vigo	6	12.24%	24	48.98%	5	10.20%	1	2.04%	13	26.53%

- To assess the correspondence between the titles most widely chosen for use and their academic prestige, as well as the relationship between the preferences emerging and the holdings previously subscribed to in paper format.
- To gain an understanding of the behaviour in respect of the use of information of the different subject areas that make up the academic communities studied.

The period investigated ran from the beginning of purchase of electronic resources by consortia, which goes back to 2002, down to the year 2009.

As the periods over which subscriptions have been in place are not the same for all the packages in all the universities, not all of them fully cover the time-span indicated. Some institutions have data available only from 2003 or 2004 onwards. For the earlier years of subscriptions, only overall download data were considered.

From 2005 on, this being the year in which a sufficient degree of consolidation in the use of electronic publications in the group of universities as a whole was observed, analysis can be enriched with data on downloads per titles. The figures provided by suppliers of electronic journals to each of the libraries studied were taken into account. These were annual Excel files with details for monthly downloads of full-text articles, broken down by journal titles. From these it was possible to calculate precisely what usage was to be assigned to the package subscribed to from each publisher. The universities of Salamanca and Valladolid lack full data for 2006.

The indicators established for the purpose of analysis were organised into the following groupings:

1. Data on overall downloads broken down by institution and by year.
   - Articles downloaded by supplier and by institution annually.
   - Evolution in the number of titles subscribed to, titles actually used, and core titles in each institution annually.
     The threshold taken into account in establishing which titles constituted the core was a total of ten or more downloads for any given title.
2. Data on the titles by each institution in 2006 and 2009.
   - Rates of dispersion and of concentration of use, by institution.
     The dispersion rate for any supplier was determined by the ratio between titles used and titles for which subscriptions were held. The ratio between core titles and titles used gives the rate for concentration of use.
3. Study of the titles most widely used in the institutions as a group from 2006 to 2009.
   - The core of titles coinciding in the five universities.
   - Rating of publications in the JCR and SJR.
   - Correspondence between titles and academic fields.
   - Relationship with previous subscriptions in print format.
4. Analysis of core collections by distributor and institution.
   - Data on cumulative downloads from 2006 to 2009.
   - Study of recurring titles between institutions.
   - Individualised usage profiles.

Results

They are organised into three blocks. The first covers changes in usage. The second considers titles whose use is common and steady, looking at quality, subjects and the relationship to titles subscribed to in print form. The third investigates shared patterns of usage and individualised consumption profiles.

Changes in use

The results in this section are split into two parts. The first considers changes in consumption by institution and supplier; the second looks at dispersion and concentration rates.

Changes in usage by institution and supplier

It can be seen that in Burgos (Figure 1) there was an undoubted growth in the use of ScienceDirect, with a continuous rise being traced. There is also a clear liking for Wiley and Emerald, whilst there was a similar growth over the last two years in downloads from SpringerLink, which rose from 838 in 2002 to 3700 in 2009.

The significant use made of Emerald in this university may be an outcome of the substantial number of degree programmes in social sciences taught there. These amount to half of total of degree courses, with the number of staff working in areas of this field being correspondingly large (Figure 2).

A significant growth in the number of titles subscribed to can be seen in 2009, with a slight increase in the titles actually used and in core titles with more than 10 downloads over the last four years. Hence, it is possible to talk in terms of a small rise in the consumption of academic information. It would seem that the size of this university, the smallest of those under consideration here, would be related to the fact that the titles not used were more numerous than those actually consulted.

In León (Figure 3) a peaking of consumption may be observed in the year 2008 for ScienceDirect, SpringerLink and Wiley. Disregarding this apparently one-off event, possibly attributable to isolated intensive use, which, as pointed out by Davis and Solla[30], can be the outcome of student involvement in completion of tasks set, the University of Leon was in a situation of stability in the use of the electronic resources being investigated.

Points of note are the liking in this university for the use of ScienceDirect and the slight preference for contents from Springer, rather than those from Wiley (Figure 4).

Figure 1
University of Burgos — evolution of downloads by year.

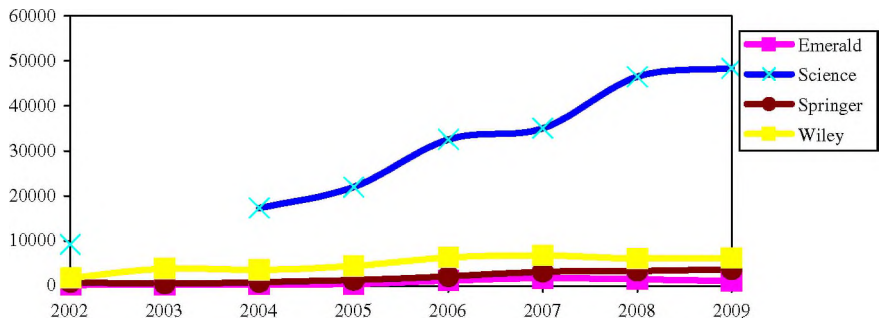


Figure 2
University of Burgos — titles evolution by year

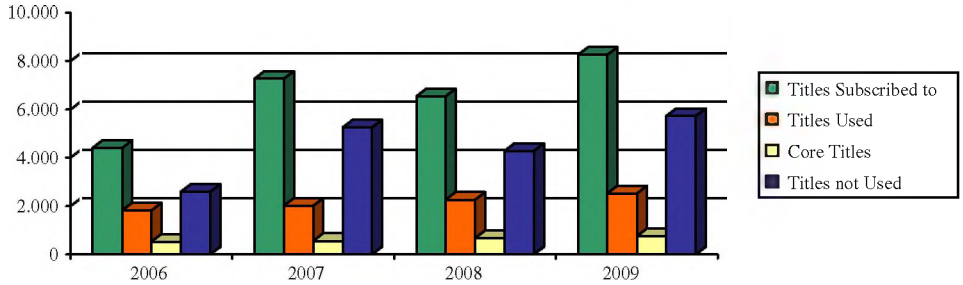
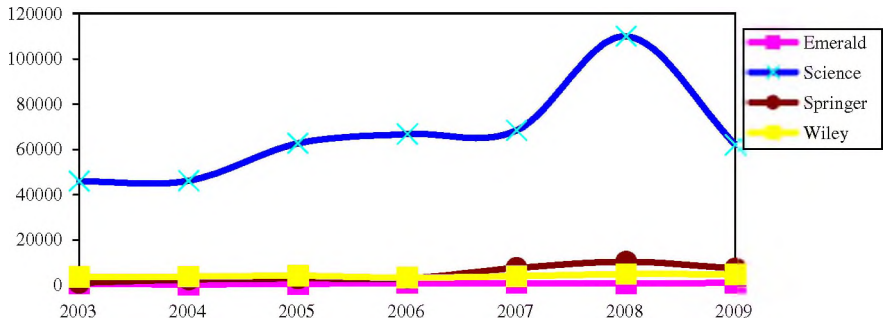


Figure 3
University of Leon — evolution of downloads by year



A very modest growth in the number of titles subscribed to can be noted. The figures for titles used and for core titles, as was indicated above, were larger in 2008, relative to 2007 and 2009, which had similar data, showing a tendency to stability, as noted. As in the case of Burgos, the size of this university, the second smallest, most probably has an outcome in the substantial number of titles not used. Nevertheless, logically enough, the contrast observed between titles used and not used is not as significant as in Burgos.

Data from University of Salamanca (Figure 5) are to hand only from 2006 onwards. In that year only the figures of overall downloads are available.

It can be seen that in this university there is a more balanced distribution in the usage of information from the various packages under scrutiny. Nonetheless, the liking for contents distributed by ScienceDirect is still striking. The use made of journals from Springer and Wiley is similar, even if there appears to be a slight preference for the second. Use of Emerald, on the other hand, has declined over the last couple of years.

Taken all in all, it is possible to talk in terms of stability in the use of electronic resources distributed by Emerald, ScienceDirect, Springer and Wiley (Figure 6).

The considerable increase in the number of titles subscribed to in 2009 is striking. This was correlated to a rise in the number of titles actually used. Nevertheless, the total of titles forming the core remained stable.

For its part, the number of titles not used grew in parallel with the total number of titles subscribed to, although always remaining smaller than the figure for titles actually used. It is worth pointing out that in 2007 and 2008 the quantity of titles not used was smaller than that of titles forming the core, with a more balanced relationship between supply and demand in those two years.

Figure 4
University of Leon — titles evolution by year

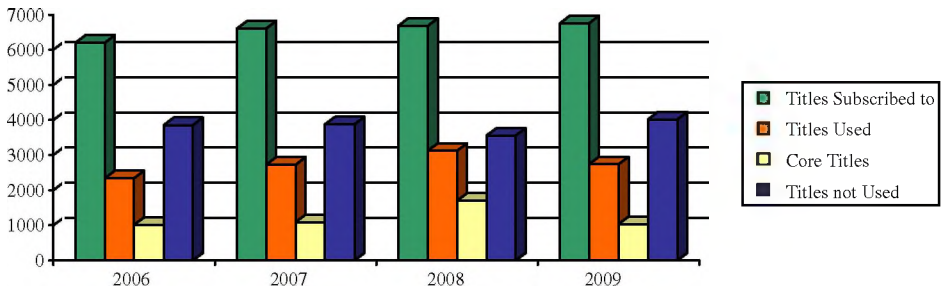


Figure 5
University of Salamanca — evolution of downloads by year

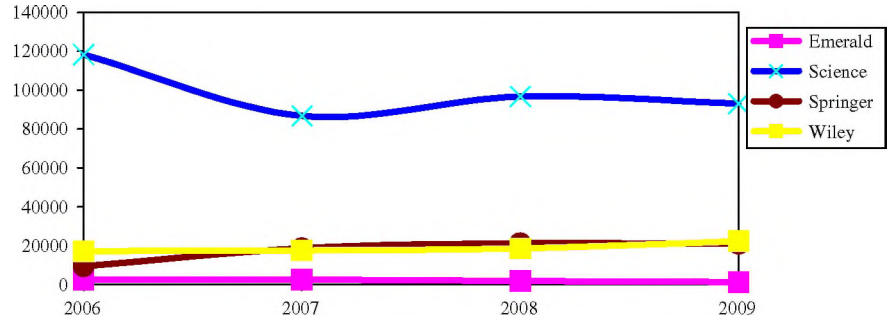
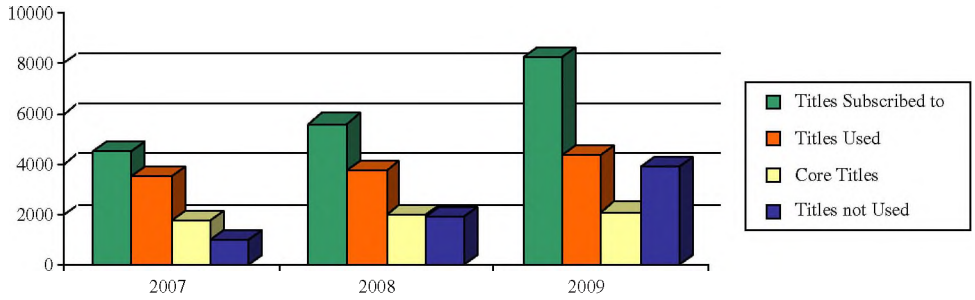


Figure 6
University of Salamanca — titles evolution by year



In Valladolid (Figure 7) no data on downloads from SpringerLink in 2006 are available and the data for Wiley begin in 2006.

The use of articles in electronic format from the suppliers under consideration showed a rising trend in the case of all the publishers involved. In comparison with the University of Salamanca, which is of similar size, there was a greater use made of ScienceDirect. In contrast, downloads from SpringerLink and Wiley were fewer than there, a certain preference being visible for contents from Springer (Figure 8).

A slight increase over the last three years may be seen in the figures for titles subscribed to, titles actually used and core titles. It is noteworthy that the number of journals not used was considerably lower than the figure for titles used and similar to the number of titles in the core. This indicates that rather appropriate use was made of the collections for which subscription contracts were held.

The University of Vigo (Figure 9) makes a much more intense use of electronic resources than the universities in the Castile and Leon Region. A continuing increase in the consumption of electronic information from all the suppliers studied is observed. Furthermore, the rate of growth is still rising.

Of particular note is the usage of titles from ScienceDirect, especially in the years 2008 and 2009, during which downloads were considerably higher than those undertaken in universities of greater size, like Salamanca and Valladolid. The graph clearly reflects this exponential growth (Figure 10).

A progressive increase in the number of titles subscribed to may be observed, as also of titles downloaded. In respect of titles not being used at all, in every year considered they were fewer than the total of titles actually used.

Figure 7
University of Valladolid — evolution of downloads by year

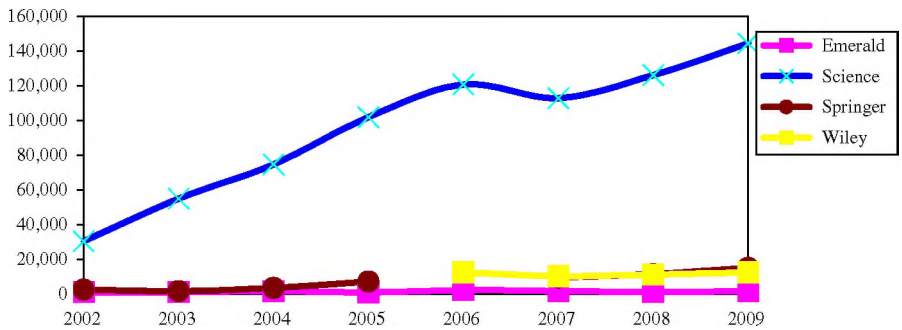


Figure 8
University of Valladolid — titles evolution by year

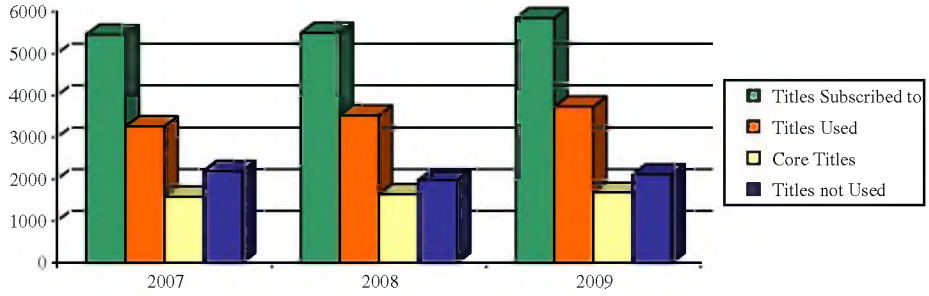
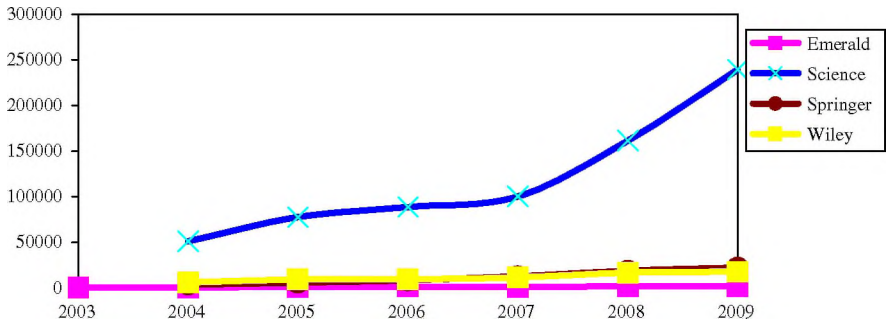


Figure 9
University of Vigo — evolution of downloads by year



A considerable growth can be seen in the number of core titles in 2008 and 2009. In this latter year the core increased in so strong a way that it exceeded the total of titles no downloaded. This would appear to be an indication that the consumption of electronic contents at this university has been becoming steadily more intense. These data seem to be confirmed by the 2010 report from the Bugalicia consortium[31], which carried out a detailed study of downloads of articles in electronic format up to October 2010 with figures on eight packages subscribed to as purchases through the consortium: ACS, Cambridge, Cell, IEE Journals, JSTOR, ScienceDirect, Springer and Wiley. It discovered that 77.08% of titles did receive some use in this university and that the core of titles was composed of a percentage close to 40%.

Dispersion and concentration rates by institution

As was indicated in the section on the methods employed, the threshold used in establishing which titles constituted the core was a total of ten or more downloads each year. The ratio between titles used and titles subscribed to yields the dispersion rate for any provider. The ratio between core titles and titles used gives the concentration rate for use.

In the three universities where it is feasible to make a comparison between 2006 and 2009, it is possible to see varying patterns of consumption. In Burgos, the number of titles subscribed to increased very significantly. There was also growth in the numbers of titles used and core titles. Nonetheless, this was not sufficient to prevent the dispersion rate showing a drop of more than 10%; in contrast, in this university the concentration rate remained stable.

Leon, for its part, had very moderate growth in the number of titles subscribed to. A slight growth in dispersion was also observed and the concentration rate, on the contrary, dropped by approximately five points.

The University of Vigo was the one with the fewest titles subscribed to from the publishers under consideration and also the

Figure 10
University of Vigo — titles evolution by year

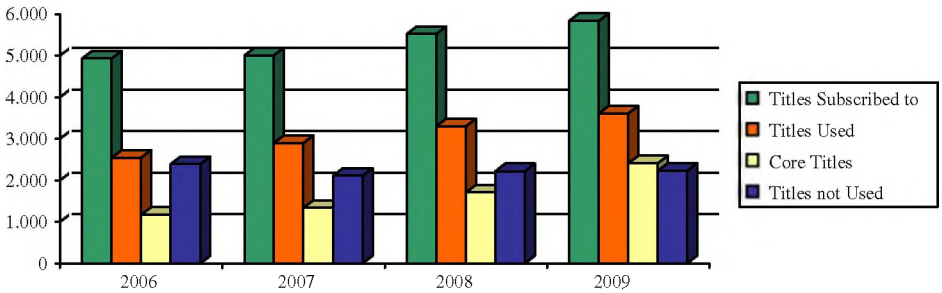


Table 2

Dispersion and concentration rates by institution

	Burgos		Leon		Salamanca		Valladolid		Vigo	
	2006	2009	2006	2009	2006	2009	2006	2009	2006	2009
Downloads of articles	42,274	59,437	74,166	75,223	147,016	137,504	–	173,434	107,848	281,222
Titles subscribed to	4411	8255	6200	6756	–	8265	–	5854	4931	5832
Titles used	1816	2522	2344	2741	–	4366	–	3737	2543	3608
Core titles	530	757	1015	1038	–	2084	–	1684	1166	2407
Dispersion rate	41.16%	30.55%	37.80%	40.57%	–	52.82%	–	63.83%	51.57%	61.86%
Concentration rate	29.18%	30.01%	43.30%	37.86%	–	47.73%	–	45.06%	45.85%	66.71%

one using them most intensely. Its concentration rate grew by more than 20 points, reaching a figure close to 67%. With regard to dispersion, this grew by 10 points. This rate is comparable to the rate in Valladolid. The pattern of consumption appears similar at both universities, they are the two with the smallest number of titles subscribed to and with the most downloads of articles in 2009.

The University of Salamanca, like Burgos, has a very large number of titles subscribed to at present. However, its larger size leads its dispersion and concentration rates to be higher than those of University of Burgos.

It is possible to see how the dispersion rate grew in all the universities in 2009, except in Burgos, and the concentration rate in all, except Leon.

In 2009 the three largest universities made use of these resources to the extent of more than half of the titles available from the packages considered. This trend was also to be seen in 2006 at the University of Vigo.

Despite the dispersion rates observed, which, as previously pointed out, grew slightly in 2009, except in the University of Burgos, the percentages shown in Table 2 confirm that there is considerable concentration of usage, focussed on very few titles. This is true even in the universities of Burgos and Leon, which have lower concentration rates.

With the data on representativeness of the favourite titles among total downloads overall in 2009, a similar pattern of behaviour is observed in four of the universities. Thus, with the exception of the University of Valladolid, a percentage greater than 15% of all downloads comes from the ten most widely used titles, and between 24% and 30% from the favourite 25 titles of the academic communities under scrutiny.

It would seem that researchers at the University of Valladolid have a model of consumption with a higher dispersion rate and lower concentration rate than those at other universities of similar size. This tendency can be observed in Table 3, in which it may be seen that academics from Valladolid do not show such decided preference for the titles with the highest priority rankings positions and spread their downloads over a larger core of journals.

In view of the unquestionable representativeness of the top 25 titles with regard to the overall consumption of electronic information, this cut-off point was adopted for the analysis of the favourite journals of the academic communities under study and to determine how far they coincide or differ in their choices.

Table 3

Weighting of favourite titles within total downloads

Downloads 2009	Burgos	Leon	Salamanca	Valladolid	Vigo
Top 10	18.68%	20.96%	15.36%	6.69%	15.65%
Top 15	24.10%	23.91%	19.29%	8.87%	20.17%
Top 25	30.94%	28.86%	24.92%	12.17%	24.47%

Analysis of journals commonly and regularly used: quality, subjects and relationship to titles subscribed to in print format

For each of the universities, consideration was given to all titles with more than 500 downloads in every year from 2006 to 2009 in the case of Burgos, Leon and Vigo, and from 2007 to 2009 in the universities of Salamanca and Valladolid. The results from the five universities are compared and the recurring titles have been selected. These comprise 29 journals, all distributed by ScienceDirect. The following table shows these publications together with a cumulative download total for the years involved, plus their impact factors for 2009 from the *Journal Citation Report* (JCR) and the *Scimago Journal Report* (SJR) (Table 4).

All of these journals have an impact factor in both the *Journal Citation Report* and the *Scimago Journal Report*. The title with the greatest impact factor in both these indexes is *Free Radical Biology and Medicine*. In the SJR, the next place is held by *Analytical Biochemistry*, whilst in the JCR this goes to *Water Research*.

None of the coinciding titles most widely used by the universities under study had very high impact factors. It should be noted that *Free Radical Biology and Medicine*, the title coming in first place in the table above, falls in position 303 in the *JCR Science Edition* out of a total of 7387 titles with an impact factor in 2009. The same publication comes in position 450 out of 18,732 titles in the SJR.

It is striking that one of the social science titles used most intensively in the universities studied, that is, the *European Journal of Operational Research*, comes in tenth place in terms of total downloads

It is possible to see continuity in the usage preferences of the universities involved. This can be deduced from the fact that 13 out of the 29 titles listed above also appeared among the favourites of a group of universities in the North-west of Spain in the year 2005, three of the universities studied in the present article, Burgos, Leon and Vigo, being in that group[32]. The titles in question are *Food Chemistry*, *Journal of Chromatography A*, *Analytica Chimica Acta*, *Bioresource Technology*, *Water Research*, *Talanta*, *Chemosphere*, *Soil Biology and Biochemistry*, *Science of the Total Environment*, *Bioorganic and Medicinal Chemistry Letters*, *Journal of Materials Processing Technology*, *Process Biochemistry* and *Atmospheric Environment*. It is

Table 4
Coinciding titles over 500 downloaded

Titles	Downloads	JCR	SJR
Food Chemistry	28,018	3.146	0.140
Journal of Chromatography A	24,806	4.101	0.289
Analytica Chimica Acta	19,018	3.757	0.231
Bioresource Technology	18,327	4.253	0.171
Water Research	10,783	4.355	0.204
Talanta	10,665	3.290	0.197
Chemosphere	10,179	3.253	0.165
Journal of Food Engineering	9465	2.313	0.102
Soil Biology and Biochemistry	8977	2.978	0.159
European Journal of Operational Research	8737	2.093	0.070
Journal of Hazardous Materials	8289	4.144	0.152
Science of The Total Environment	8055	2.905	0.142
Bioorganic and Medicinal Chemistry Letters	7669	2.650	0.228
Journal of Materials Processing Technology	6768	1.420	0.079
Free Radical Biology and Medicine	5256	6.081	0.615
International Dairy Journal	5230	2.409	0.140
Enzyme and Microbial Technology	5148	2.638	0.141
Food Control	5007	2.463	0.107
Journal of Chromatography B	4989	2.777	0.238
Process Biochemistry	4970	2.444	0.126
Analytical Biochemistry	4606	3.287	0.298
Food Microbiology	4389	3.216	0.169
Atmospheric Environment	4326	3.139	0.180
Trends in Food Science and Technology	3772	4.051	0.205
Journal of Pharmaceutical and Biomedical Analysis	3733	2.453	0.181
Biochemical Engineering Journal	3137	2.193	0.113
International Journal of Pharmaceutics	3085	2.962	0.202
Journal of Food Composition and Analysis	3002	2.423	0.122
Journal of Business Research	2754	1.293	0.046

to be noted that relative to 2005 the impact factor given by the JCR has increased for all of these journals.

Consideration of an analysis of the coinciding favourite titles from ScienceDirect in ten universities in the United Kingdom, chosen from those in the top five places in each of the institutions concerned[33], shows that four of these were also found to be favourites in the work being reported here. These included two chemistry journals, *Journal of Chromatography A*, *Journal of Chromatography B*, and two titles relating to environmental sciences, *Chemosphere* and *Science of the Total Environment*. *Journal of Chromatography A* is a title preferred by all five universities analysed here, while *Journal of Chromatography B* was particularly intensively used at the University of Salamanca, *Science of the Total Environment* in Vigo and *Chemosphere* in Valladolid and Vigo.

In the research carried out by Nicholas, Huntington and Jamali[34] on the basis of log files running from January 2005 to April 2006 in four universities belonging to the OhioLINK consortium, the second most preferred journal in the social science area in the current study, the *Journal of Business Research*, was one of the 20 top titles most widely used in those universities undertaking intensive research within this American consortium.

It may be seen from Table 5 that the most widely representative subject areas were chemistry, biochemistry, biotechnology, food sciences and environmental sciences.

In view of the titles most often downloaded common to all the universities considered, it may be deduced that it is researchers in the fields of chemistry and biology who made most intensive use of electronic publications. As has been noted in a number of papers[35, 36] academics in the exact sciences and natural sciences are the most given to using electronic journals. This tendency has a two-fold origin. On the one hand, in the packages of journals for which subscriptions are held there are a majority of publications from these scientific fields. On the other, there has traditionally been a tendency for researchers in experimental sciences to put reliance on journals.

"It may be deduced that it is researchers in the fields of chemistry and biology who made most intensive use of electronic publications."

On this point, specifically in relation to chemistry, as long ago as 1956 Brown[37] pointed out that people working in the chemistry area were known for being the greatest users of journals, whilst Tenopir and King[38] noted that chemists tended to spend more time reading than most scientists. Finally, Walsh and Bayma[39] suggest as a fundamental reason for this behaviour the fact that academics in fields closely linked to commercial markets, such as chemistry, tend to limit the use they make of informal communication networks, such as e-mail and servers offering pre-prints, relying more on formal communication through published articles.

It should be pointed out that the total enrolments in degrees in experimental sciences at the universities under consideration are not especially high, running from 6.67% of the student body in Burgos to 11.39% in Salamanca. This just goes to reaffirm the particular dedication to the reading of scientific articles by researchers in these areas and their preference for electronic contents.

As was noted in a previous study[40], differences may be observed that are related to the degree courses offered at the various institutions studied. Thus, in the case of the University of Leon, which has no full degree programme in chemistry, there is less use made of journals from this subject area.

It is a question of a rather limited recurrence between the titles most commonly and steadily selected for use and prior subscriptions in paper format. The greatest correspondence between print-format subscriptions and electronic titles was found at the University of Burgos and the smallest coincidence in Leon (Table 6).

This restricted overlap most probably is an outcome of the well-known problem of the existence of personal subscriptions not handled by the library, rather than of a radical change in the consumption habits of the academic community. It is possible that the library of the University of Burgos was quicker to take on board such subscriptions, while the remaining institutions did so more slowly. Something of the sort was noted at the University of Leon during earlier research[41].

Common usage patterns and individual consumption profiles

The titles in greatest demand from each of the various suppliers are detailed in Tables 5 to 9 for each university. These were taken from the titles in the core, being those figuring in the top 25 in each one-year

Table 5
Coinciding titles — subject areas

Titles	JCR subject areas
Food Chemistry	Chemistry, Applied, Food Science & Technology, Nutrition & Dietetics
Journal of Chromatography A	Biochemical Research Methods Chemistry, Analytical
Analytica Chimica Acta	Chemistry, Analytical
Bioresource Technology	Agricultural Engineering, Biotechnology & Applied Microbiology, Energy & Fuels
Water Research	Engineering, Environmental, Environmental Sciences, Water Resources
Talanta	Chemistry, Analytical
Chemosphere	Environmental Sciences
Journal of Food Engineering	Engineering, Chemical, Food Science & Technology
Soil Biology and Biochemistry	Soil Science
European Journal of Operational Research	Operations Research & Management Science
Journal of Hazardous Materials	Engineering, Environmental, Engineering, Civil, Environmental Sciences
Science of The Total Environment	Environmental Sciences
Bioorganic and Medicinal Chemistry Letters	Chemistry, Medicinal, Chemistry, Organic
Journal of Materials Processing Technology	Engineering, Industrial, Engineering, Manufacturing, Materials Science, Multidisciplinary
Free Radical Biology and Medicine	Biochemistry & Molecular Biology, Endocrinology & Metabolism
International Dairy Journal	Food Science & Technology
Enzyme and Microbial Technology	Biotechnology & Applied Microbiology
Food Control	Food Science & Technology
Journal of Chromatography B	Biochemical Research Methods
Process Biochemistry	Biochemistry & Molecular Biology, Biotechnology & Applied Microbiology, Engineering, Chemical
Analytical Biochemistry	Biochemical Research Methods, Biochemistry & Molecular Biology, Chemistry, Analytical
Food Microbiology	Biotechnology & Applied Microbiology, Food Science & Technology, Microbiology
Atmospheric Environment	Environmental Sciences, Meteorology & Atmospheric Sciences
Trends in Food Science and Technology	Food Science & Technology
Journal of Pharmaceutical and Biomedical Analysis	Chemistry, Analytical, Pharmacology & Pharmacy
Biochemical Engineering Journal	Biotechnology & Applied Microbiology, Engineering, Chemical
International Journal of Pharmaceutics	Pharmacology & Pharmacy
Journal of Food Composition and Analysis	Chemistry, Applied Food Science & Technology
Journal of Business Research	Business

period and to be found in the top rankings for cumulative downloads calculated for the years between 2006/2007 and 2009. It should be pointed out that certain titles which achieved substantial numbers of downloads were eliminated from consideration because they were not in the top 25 in all years.

In the case of ScienceDirect, in view of the much heavier volume of downloads, the threshold used was those titles with 50 or more downloads in each year, rather than those with 10 or more. This second figure constituted the dividing line for assignment to the core for the remaining distributors.

Emerald

It is striking how limited the number of downloads of titles from this distributor was in the set of universities studied, in light of the fact that in all five institutions enrolments in social science degrees were very large, going from 30% of students in Salamanca to 50% in Burgos. No significant differences were observed relating to the size of the various institutions. Indeed, as pointed out, the volume of downloads was noteworthy at the University of Burgos, the institution smallest in size.

Specifically, it was recorded that at the University of Salamanca seven journals from Emerald achieved more than 200 downloads, in Burgos five titles, in Valladolid four, at the University of Vigo two, while in Leon there were no titles reaching this level.

The recurrence in use of titles from this provider picked out at the five universities amounted to just eight journals, these being listed in Table 7.

Just three titles coincided in three universities. These were the *European Journal of Marketing*, which in Leon and Valladolid was the most frequently used title from this supplier. In respect of the journals *International Journal of Operations and Production Management* and *Management Decision*, the coincidence between these two titles was found in the three largest universities. It should be noted that these are journals that were also among the top 10 at the University of Vigo, falling in third and sixth positions respectively.

It may be seen that, although this is a distributor concentrating fundamentally on social sciences, specialising particularly in the areas of economics, education and information science, some of the most widely used titles belonged to the food science sector. This was the case for the *British Food Journal* in Burgos and for *Nutrition and Food Science* in Leon.

At the University of Salamanca there were three periodicals dealing with information science among the group of journals most often downloaded: *Journal of Documentation*, *Library Hi Tech* and *The Electronic Library*. At the University of Leon the *Journal of Documentation* was the second most used title from Emerald. In Vigo, lacking any full degree course specifically in librarianship, the title *Library Management* turned out to be the fifth most widely used journal.

Taking account of a study carried out into the titles most frequently used at the universities of Burgos and Leon in 2005[42], it is possible to note that, of the six periodicals most widely used in that year, half coincides with the journals most often utilised in the period now being considered. These were the *European Journal of Marketing* and *Journal of Intellectual Capital* in both universities and the *Journal of Documentation* in Leon.

ScienceDirect

The large number of publications that forms the core from this provider, as indicated above, rendered it necessary to limit consideration to those journals most often accessed. Table 8 shows the titles with the most downloads that coincide in more than two universities in having heavy and steady use made of them during the years studied.

As is logical, a number of these titles are shared with Table 4, which shows titles with more than 500 downloads coinciding across the five universities. Specifically, there are twelve journals that appear in both tables.

It can be noted that in the universities of Burgos, Leon and Valladolid none of the titles attained 6000 downloads over the range of years considered. In contrast, in Salamanca there were three titles that exceeded 6000 downloads and in Vigo seven (Table 8).

A common behavioural pattern can be seen in the preferences of the universities of Burgos and Valladolid, which coincide with some other university in respect of their usage in somewhat more than 60% (20 titles). The degree of similarity in preferences between these two institutions is likewise high, reaching nearly 50% (14 titles).

The universities with the most individualistic profiles are those of Leon and Salamanca. The University of Vigo, for its part, lies in an intermediate position.

Table 6

Coinciding titles — print subscriptions

Title	Burgos	Leon	Salamanca	Valladolid	Vigo
Food Chemistry	√				√
Journal of Chromatography A					
Analytica Chimica Acta	√		√	√	
Bioresource Technology	√			√	√
Water Research	√	√	√	√	
Talanta	√		√	√	
Chemosphere					√
Journal of Food Engineering	√				
Soil Biology and Biochemistry	√				√
European Journal of Operational Research			√	√	√
Journal of Hazardous Materials					
Science of The Total Environment					
Bioorganic and Medicinal Chemistry Letters			√		
Journal of Materials Processing Technology					√
Free Radical Biology and Medicine	√				
International Dairy Journal					
Enzyme and Microbial Technology	√				
Food Control	√				√
Journal of Chromatography B					
Process Biochemistry	√	√			
Analytical Biochemistry					
Food Microbiology	√	√			√
Atmospheric Environment	√		√	√	
Trends in Food Science and Technology	√	√			
Journal of Pharmaceutical and Biomedical Analysis			√		
Biochemical Engineering Journal	√				
International Journal of Pharmaceutics					
Journal of Food Composition and Analysis	√			√	
Journal of Business Research					√

It may be observed that only the periodicals *Food Chemistry* and *Journal of Chromatography A* are priority titles at all five universities. With regard to the first of these, it is the journal in most demand in Burgos and Valladolid, the third most often downloaded in Vigo, the fourth in Leon and the sixth in Salamanca. In respect of *Journal of Chromatography A*, it may be stated to hold the following positions: third in Salamanca, fourth in Vigo, sixth in Burgos and Valladolid and seventeenth in Leon.

Analytica Chimica Acta, *Bioresource Technology*, *Tetrahedron Letters* and *Water Research* are titles very often downloaded and holding priority status in four of the five universities studied. In reference to *Tetrahedron Letters*, this can be seen to be the most frequently used journal in Vigo, with more than 17,000 downloads, and the second most popular in Burgos and Salamanca.

For their part, *Fluid Phase Equilibria*, *Journal of Food Engineering*, *Journal of Organometallic Chemistry* and *Tetrahedron* lie among the preferences of three universities. The latter is the most frequently used journal in Salamanca, with more than 11,000 recorded downloads.

As may be seen in Table 5, which covers the subject areas of coinciding titles, here too the journals picked out are predominantly from the field of chemistry, with a certain presence of titles from food science, environmental studies and medicine. However, the area of health sciences is not widely represented in the universities considered, running from 2.4% of enrolments at the University of Vigo to 12.96% at the University of Leon, where the prominent presence of veterinary studies makes itself felt. Nonetheless, one of the most prestigious titles, *The Lancet*, with an impact factor for 2009 in the JCR of 30.758, is amongst the most frequently downloaded in Salamanca and Valladolid, the only two institutions where medical degrees are offered.

When account is taken of the previously mentioned study on which journals were favourites in 2005 in universities in the North-west of Spain, which included the universities of Burgos, Leon and Vigo[43], a considerable degree of recurrence is to be seen among the titles most often downloaded. This is greater than 80%, with a total of 26 titles also in the 32 given in Table 8.

With regard to the titles recorded in the CIBER study[44], a substantial coincidence may be observed in the use of chemistry journals. Thus, from the group of eleven titles coinciding in the universities in the United Kingdom, six are also to be found in the list of titles presented in Table 8, *Tetrahedron Letters*, *Tetrahedron*, *Journal of Chromatography A*, *Polymer*, *Journal of Organometallic Chemistry* and *Journal of Membrane Science*. It is noteworthy that the first two of these journals were to be found in the top five of the universities investigated in the CIBER report.

There is less coincidence in the fields of environmental and life sciences among the favourite titles of the Spanish universities studied here and the universities in the United Kingdom. In the first of these areas, two journals coincide, *Forest Ecology and Management* and *Chemosphere*. In the life sciences area there are also two coinciding titles: *Biochemical and Biophysical Research Communication* and *FEBS Letters*.

According to the study carried out by Nicholas, Huntington and Jamali[45] there are several titles from this provider which are favoured in use in American universities undertaking intensive or extensive research and which coincide to some degree with the preferences of the British universities in question and with the publications most frequently utilised in the Spanish institutions under consideration here. These are, *Biochemical and Biophysical Research Communication*, *FEBS Letters*, *Journal of Business Research*, *Polymer*, *Journal of Power Sources*, *Tetrahedron*, *Tetrahedron Letters* and *The Lancet*.

Due to the large number of titles with high totals of downloads from this distributor, a selection of individualised preferences for each university is shown in Table 9.

There are various journals shared with Table 4, in which those titles receiving more than 500 downloads are listed. Specifically, seven periodicals appear in both these tables.

With regard to the distinctive features that characterise each of the universities, the information in this table points up the particular trends of use of this provider by the universities of Salamanca and Vigo. The majority of the titles most often requested by their academic communities did not coincide with the favourites at the remaining universities. In respect of the University of Leon, it is noteworthy that some of the titles figuring in Table 9 were among those most often used at this university from the whole set of resources for which it held subscriptions. This would be the case for *Theriogenology*, which accumulated 4713 downloads over the years under consideration. The opposite situation applies to the academic communities of Valladolid and Burgos, with two and three titles respectively that were favourites there but did not coincide with the patterns of consumption at the remaining institutions studied.

It should be stressed that of the 18 favourite titles at the University of Burgos in 2005, 12 coincided with the most frequently used titles identified in the current article. In the case of Leon, of the total of 17 titles picked out as most often used in 2005, nine coincided with the current list. The first position by number of downloads was also occupied by *Theriogenology* in 2005[46]. This same sort of recurrence was noted at the University of Vigo, where there were five titles belonging to the field of environmental sciences that are repeated in Table 9[47]. Researchers' preferences can thus be observed to have persisted unchanged to an appreciable extent.

With regard to the analyses from the CIBER study[48], of the eleven journals picked out in the life sciences field in the United Kingdom

Table 7
Coincidences relating to Emerald

Titles	Burgos	Leon	Salamanca	Valladolid	Vigo
European Journal of Marketing	√	√		√	
International Journal of Operations and Production Management			√	√	√
Internet Research	√			√	
Journal of Business and Industrial Marketing	√			√	
Journal of Documentation		√	√		
Journal of Intellectual Capital	√				√
Journal of Knowledge Management				√	√
Management Decision			√	√	√

Table 8
Coincidences relating to ScienceDirect

Titles	Burgos	Leon	Salamanca	Valladolid	Vigo
Analytica Chimica Acta	√		√	√	√
Biochemical and Biophysical Research Communication		√	√		
Bioorganic and Medicinal Chemistry Letters			√		√
Bioresource Technology	√	√		√	√
Bioorganic and Medicinal Chemistry			√		√
Chemical Engineering Science			√	√	
Chemical Physics Letters	√			√	
Chemosphere				√	√
Desalination	√			√	
FEBS Letters		√	√		
Fluid Phase Equilibrium	√			√	√
Food Control	√	√			
Food Chemistry	√	√	√	√	√
Forest Ecology and Management		√		√	
Free Radical Biology and Medicine		√	√		
Inorganic Chimica Acta	√				√
International Journal of Food Microbiology		√			√
Journal of Chromatography A	√	√	√	√	√
Journal of Food Engineering		√		√	√
Journal of Materials Processing Technology		√		√	
Journal of Membrane Science	√			√	
Journal of Organometallic Chemistry	√			√	√
Journal of Power Sources	√				√
Meat Science	√	√			
Polyhedron	√				√
Polymer	√			√	
Soil Biology and Biochemistry	√				√
Tetrahedron	√		√	√	
Tetrahedron Letters	√		√	√	√
The Journal of Supercritical Fluids	√			√	
The Lancet			√	√	
Water Research	√	√	√	√	

universities, two titles appeared among the favourites at the University of Vigo. These were *Aquaculture* and the *Journal of Experimental Marine Biology and Ecology*. In relation to the titles in the chemistry field that were preferred choices at the British universities a certain coincidence with the favourites among the scientists in Vigo could be seen, as well. This related to journal *Biomaterials*, which also appeared among the patterns of preferred use in the universities undertaking intensive and extensive researches in the OhioLINK consortium, together with the *Journal of Colloid and Interface Science* which came in nineteenth place among the universities involved in intensive research[49]. Finally, in the area of environmental sciences the journals *Science of the Total Environment* and *Forest Ecology and Management* were titles receiving heavy use in Vigo and in Salamanca respectively. Greater similarity was to be seen in the choice of contents at the University of Vigo relative to the United Kingdom universities than at the other Spanish institutions investigated.

There did appear to be individual profiles of consumption, especially at the universities of Salamanca, Vigo and Leon. On these lines, there was a predominance of titles relating to medicine in Salamanca, to marine studies in Vigo and to veterinary science in Leon.

In the case of Burgos, it is of interest to note the presence of titles in anthropology among the periodicals most frequently used, such being the case for the *Journal of Human Changes*. This may bear some relation to the relevance for this University of the presence near it of the deposits of palaeontological value at Atapuerca. As for the single title from the pure sciences recorded in the table, the *Journal of Mathematical Analysis and Applications*, it was the second most frequently used periodical at the University of Vigo totalling 9754 downloads.

SpringerLink

It is noteworthy that there was only a moderate volume of downloads per title from this multidisciplinary provider with a considerable number of journals available. Only three journals reached the level of more than 500 downloads in Burgos, five in Leon, eight in Salamanca, eleven in Vigo, but in Valladolid not one. It should, however, be kept in mind that for this university details of downloads during the year 2006 are not to hand (Table 10).

It may be seen that, over the group of universities taken together, there is little recurrence in the titles receiving heavy use. Only the journal *Applied Microbiology and Biotechnology* appeared as a favourite in four of the universities investigated. *European Food Research and Technology* was the second most widely used title in Valladolid and came in third place in Burgos and Salamanca. Apart from this periodical, *Analytical and Bioanalytical Chemistry* also appeared in three institutions.

The *Journal of Materials Science* and *Biotechnology Letters* came in third and fifth places among the most heavily utilised journals at the University of Valladolid. In Vigo these same periodicals came in seventh and eighth places, respectively, in terms of greatest numbers of downloads.

It can be stated that a rather consistent use was made of titles over the course of the decade. In the work involving universities in the North-west of Spain which included details of the preferred titles in

Table 9

Non-coinciding preferred titles from ScienceDirect

Titles	Burgos	Leon	Salamanca	Valladolid	Vigo
Animal Feed Science and Technology		√			
Aquaculture					√
Atmospheric Environment				√	
Biomaterials					√
Brain Research			√		
Current Opinion in Cell Biology			√		
Earth and Planetary Science Letters			√		
Electrochimica Acta	√				
Environmental Pollution					√
Estuarine, Coastal and Shelf Science					√
European Journal of Operational Research				√	
Experimental Cell Research			√		
Food Microbiology		√			
Fungal Genetics and Biology			√		
Hearing Research			√		
International Dairy Journal		√			
International Journal of Heat and Mass Transfer					√
Journal of Colloid and Interface Science					√
Journal of Chromatography B			√		
Journal of Experimental Marine Biology and Ecology					√
Journal of Human Changes	√				
Journal of Mathematical Analysis and Applications					√
Leukaemia Research			√		
Marine Geology					√
Marine Pollution Bulletin					√
Neuroscience			√		
Neuroscience Letters			√		
Palaeogeography, Palaeoclimatology, Palaeoecology			√		
Phytochemistry			√		
Science of the Total Environment					√
Talanta	√				
Tetrahedron: Asymmetry			√		
Theriogenology		√			
Veterinary Microbiology		√			

Table 10
Coincidences relating to SpringerLink

Titles	Burgos	Leon	Salamanca	Valladolid	Vigo
Analytical and Bioanalytical Chemistry	√		√		√
Applied Microbiology and Biotechnology		√	√	√	√
Biotechnology Letters				√	√
European Food Research and Technology	√		√	√	
Journal of Materials Science				√	√
Plant and Soil	√				√

Burgos, Leon and Vigo in 2005, the first four titles shown in Table 10 also appeared[50].

In another study focussing exclusively on the journals most often used in the universities of Burgos and Leon in 2005[51], seven periodicals were picked out in Burgos, of which three coincided with those identified in the present study. These were *Biology and Fertility of Soils*, *Analytical and Bioanalytical Chemistry* and *European Food Research and Technology*. In Leon, for its part, four out of twelve titles coincided, among them two of those receiving the greatest numbers of downloads, the *European Journal of Applied Physiology* and *Applied Microbiology and Biotechnology*.

Wiley

This multidisciplinary provider is smaller than Springer, but a slightly larger number of downloads among favourite titles was noted than was the case for SpringerLink. At the University of Burgos eleven titles reached more than 500 downloads, in Salamanca fourteen, in Valladolid twelve, in Vigo sixteen, but only one in Leon (Table 11).

The level of agreement in the preferences of the universities with regard to use of titles from this provider was greater than was the case for Emerald and SpringerLink.

Angewandte Chemie International Edition was the most widely used title from this supplier in all the universities except Leon. It was noteworthy that the number of downloads from this journal in all the other four institutions was much greater than that for the titles coming second. The *European Journal of Organic Chemistry* came among the highest rankings in the universities studied, once again with the exception of Leon. For its part, *Chemistry — A European Journal* showed up as one of the most often used titles in the universities of Salamanca and Vigo, and even reached second place in Burgos and Valladolid.

Advanced Materials was the second most widely used periodical in Vigo, while *Electrophoresis* was the title holding third place at the University of Salamanca. This same journal recorded a considerable number of downloads in Vigo.

The journal *Advanced Synthesis and Catalysis* that came in fifth place in Burgos and in Salamanca was the fourth most often downloaded title. The journal most widely used in Leon, the *Journal of the Science of Food and Agriculture*, also received considerable use in the universities of Burgos and Vigo.

For its part, the *Strategic Management Journal* was the only title from the social science area to appear among the most widely used

Table 11
Coincidences relating to Wiley

Titles	Burgos	Leon	Salamanca	Valladolid	Vigo
Advanced Materials	√			√	√
Advanced Synthesis and Catalysis	√		√		
AIChE Journal				√	√
Angewandte Chemie International Edition	√		√	√	√
Biotechnology and Bioengineering		√		√	√
Chemistry — A European Journal	√		√	√	√
Electrophoresis			√		√
European Journal of Inorganic Chemistry	√			√	√
European Journal of Organic Chemistry	√		√	√	√
Journal of Applied Polymer Science	√			√	
Journal of Chemical Technology and Biotechnology	√				√
The Journal of Comparative Neurology			√		√
Journal of the Science of Food and Agriculture	√	√			√
Proteomics			√		√
Strategic Management Journal		√		√	

journals from this provider in the universities of Leon and Valladolid. Furthermore, in Salamanca it was also among the most frequently utilised periodicals in some of the years under consideration. In Burgos, as had happened with journals from ScienceDirect, it was possible to observe among the most widely used titles two journals from the field of anthropology: the *American Journal of Physical Anthropology* and the *International Journal of Osteoarchaeology*.

It is noteworthy that in the University of Salamanca, out of the fourteen most often used, half came from the field of medicine. In contrast, in Valladolid, where there is also a degree in medicine, only one journal from this subject area appeared in a group of the titles most frequently utilised, this being *Ultrasound in Obstetrics and Gynaecology*.

Striking stability can be seen in the preferences for usage of periodicals from this supplier over the course of time. All the journals included in Table 11. had been identified as favourite titles in 2005 in the previous study involving the universities of Burgos, Leon and Vigo, among others[52]. In a further work looking into the titles most often used in 2005 in Burgos and Leon[53], there was corroboration for this consistency of consumption. Thus, the three titles from Wiley most often used in Leon that are shown in Table 11. were also among the thirteen most widely utilised in 2005. In Burgos, for its part, nine coincided out of fourteen, among those highest ranked being *Angewandte Chemie International Edition*, the *American Journal of Physical Anthropology* and two further titles in the field of anthropology, confirming a continuing preference for this subject area.

Four of the titles most frequently utilised in the universities studied here were also included among the twenty titles receiving heaviest use in the universities OhioLINK consortium. These were *Advanced Materials*, *Angewandte Chemie International Edition*, *Chemistry — A European Journal* and the *Journal of Applied Polymer Science*[54].

Discussion

The academic community in Vigo was the one making the most intensive use of electronic journals, with a steady growth affecting all the providers analysed. The universities of Burgos and Valladolid also showed a rising trend in consumption, while in Leon and Salamanca it was possible to see stability in the use of electronic contents.

With reference to details of changes in titles, over the period 2006 to 2009 there was a growth in the number of titles for which subscriptions were held in all the institutions, this being stronger in Burgos and Salamanca. The universities of smaller size, Burgos and Leon, were those with a larger total of titles not receiving any use, the figure for titles not used being larger in the case of Burgos than the total number of titles actually utilised. For their part, the universities of Valladolid and Vigo were those showing more proportionate ratios of supply and demand. Salamanca, while not quite as balanced as these two institutions, can be said to have made reasonable use of the collections for which it had subscriptions.

In respect of dispersion, in those universities where it was possible to investigate changes, considerable growth was noted in Vigo, moderate in Leon and a pronounced decline in Burgos, this being related to the increases that there were in the number of titles subscribed to. As for the intensity of use, only the University of Vigo showed a rate over 60%. The opposite end of the scale was found in Burgos and León where rates didn't reach 40%.

With regard to concentration of use, the conclusions reached in the CIBER project[55] seem significant. In this work it was found that there were considerable differences in the numbers of titles used by researchers, dependent upon their academic disciplines. Thus, only 11% of physicists stated that they read ten or more journals, whilst among chemists the corresponding percentage rose to 53%. Studies undertaken from 1977 down to 2001 by Tenopir and King indicated that American scientists read approximately 130 articles per year on average, with medical researchers holding the first place and engineers the last[56]. This average has increased in the last few years, as these same authors note[57]. On the basis of surveys that they carried out, they stated that chemists read an average of 276 articles per year, physicists an average of 204 and engineers and average of 72. Data relating to medical researchers showed an average of 322 articles read each year. However, they dedicate just 20 min on average to each article. Hence, the total time they spend on reading — 128 h a year — is less than that spent by chemists, who devote 198, followed by physicists spending 153.

The views of the Nordic school[58] can be accepted; there is a need to integrate studies on the use of electronic information into a framework that will investigate the organisational and cultural contexts in which users find themselves and their fields of study, turning academic disciplines into the units of analysis. Approaches concentrating on the use made of electronic information have not hitherto been able to explain in depth the reasons underlying use or non-use, especially the diversity between disciplines. This same line of thinking is confirmed by Talja and Maula[59] pointing out that differences can be noted in the use of such resources that relate to factors such as the size of the academic field involved, the degree of dispersion of the literature and criteria of relevance for the specific domain concerned. In a similar vein, the study carried out by the Research Information Network[60] highlighted the necessity of undertaking qualitative studies that will go deeper into the behaviour of researchers in given specific domains or disciplines, identifying the characteristics differentiating between them.

If coinciding journals attaining more than 500 downloads every year in the five universities are considered, they are found to be 29 titles distributed by ScienceDirect. This corroborates the undoubted generalised preference for contents from Elsevier. It may be mentioned that there was little correlation between the titles now preferred by the academic communities and previously held subscriptions to paper-format versions, except at the University of Burgos. However, the continuation of personal subscriptions until quite recently does not allow a rigorous assessment of the degree of loyalty of researchers to titles from previous print collections. It is noteworthy that the 29 journals making up this selection are periodicals of repute, all of them having an impact factor in both the indexes used as references, JCR and SJR. Moreover, nearly half already appeared as favoured publications in the analysis carried out of usage statistics from 2005 for the set of universities in the North-west of Spain[61], which does demonstrate persistence in consumption by researchers. The chief subject areas among these titles are chemistry, biochemistry, biotechnology, food sciences and environmental sciences.

"There was little correlation between the titles now preferred by the academic communities and previously held subscriptions to paper-format versions ...."

A predominance of subject areas from within the experimental and natural sciences can be seen in the tables of the top 25 favourite periodicals from ScienceDirect, SpringerLink and Wiley. There is a token presence of one or two journals from the field of social sciences from ScienceDirect and from Wiley that complement those selected from the Emerald list. As examples of the individualised profiles identified in the universities studied, considerable use can be observed of journals from the health sciences field in Salamanca and Leon, from marine studies in Vigo and from anthropology in Burgos.

It would now seem to be confirmed that models of consumption vary in accordance with subject areas and institutions. Such differences have been noted both in qualitative assessments, using

data gathered through surveys and interviews, and in the analysis of log files. The recent CIBER study[62] also revealed that universities attaining excellence in research had different patterns of usage from those found at institutions with lower levels of research. Academics in the highest placed institutions tended to read journals with high impact factors.

Nicholas, Huntington and Jamali[63] pointed out, in relation to a study of American universities incorporated in the OhioLINK consortium, that universities undertaking extensive research — with the largest numbers of researchers coming second in terms of student numbers — showed the highest levels of activity, largest number of pages viewed, number of sessions, number of titles scanned and of articles downloaded and had had the highest figures per capita usage. Smaller universities engaged in intensive research equalled them in their high percentage of pages looked at, and of time spent viewing each article, but not in the number of downloads.

Tenopir and King[64] found a direct correlation between researchers with greatest professional recognition and the intensity with which articles from journals were read. The CIBER analysis[65] noted on this point that intensive use of electronic journals proved to be a reliable indicator of future success in research and that it has brought with it modifications in the model of academic communication. Thus, researchers in the United Kingdom produce more articles, with more bibliographic citations, drawn from a greater range of sources, than they did two decades ago.

A research project carried out at the University of Leon[66] to investigate the visibility of the academic output of the researchers at that university between 1995 and 2006 discovered in the WoS and Scopus databases 43 titles to which there were more than ten contributions and it was observed that the presence among them of several journals from Elsevier, specifically six out of the seventeen journals receives most downloads at this university in 2005[67]. Similarly, eleven of the journals most used at that institution between 2006 and 2009 also appeared, among them six out of the seven coming in top places by the number of articles downloaded. This would seem to show that there is a clear correlation between the journals preferred for reading and those which researchers choose when seeking to publish their work. There are also coincidences between the titles chosen for communicating the results of research and the most frequently used journals from other providers, such as Springer and Wiley.

Conclusions

Over the course of the decade, a consolidation in the consumption of electronic information was observed in the five universities under study. Use of the package from ScienceDirect was seen to be much higher than that of any other providers, in all of these institutions.

In the larger universities a higher dispersion rate was seen, consistent with the greater number of potential users. The rates for Valladolid and Vigo in 2009 were higher than in Salamanca, a university having more titles included in its subscriptions. These data appear to point to a situation in which an asymptotic growth curve is developing, in which the adding of further titles would not imply any increase in consumption. It seems that the general tendency may be towards stability. As was noted by Tenopir and King[68] in their study based on the academic population in the United States, it seems that time available for reading is reaching the maximum within the capacity of researchers and that the dispersion typical of consumption of electronic information is nearing its limits.

As for intensity of use, there were significant differences in the patterns of consumption observed. The two smallest universities, Burgos and Leon, showed stability, with concentration rates not reaching 40%. The two largest universities had rates higher than 40%, whilst the University of Vigo had its own particular behaviour pattern, with an increase of twenty percentage points between 2006 and 2009 and a concentration rate which, like its dispersion rate, was higher than 60%.

The study being reported here confirms that it is scientists from the areas of experimental and health sciences who are the most assiduous users, judging by the number of downloads of articles they carried out during the period analysed. This fact is all the more striking if it is kept in mind that the majority of the degree courses in the universities under consideration are in the fields of social sciences and technological studies.

It is noteworthy that the present work verified a similar model of behaviour in the use of the collections subscribed to in the universities of Burgos, Leon, Salamanca and Vigo. In all these, from 24% to 30% of the overall total of downloads came from the top 25 favourite titles of the respective academic communities. This fact points to a need to go beyond the *Big Deal* model and strive for greater flexibility in subscriptions to resources, so as to have made-to-measure supplies. The so-called *post Big Deal* era, according to the report from the project *E-journals: Their Use, Value and Impact*[69], began in 2007. The new models proposed are seen as heading in the direction already indicated as an alternative in the study by the European Commission[70], which suggested that libraries should have the possibility of selecting groups of publications and making up their own individualised bundles of electronic resources.

Furthermore, by starting from real data on actual use of contents that reflect the needs of users, librarians could demand packages of thematic resources tailor-made for their institutions. These would be more flexible than what is currently offered under the *Big Deal* model. Awareness of patterns of use common to several institutions would allow suppliers to configure packages of this sort. Understanding of the specific profiles of usage in their own institutions would permit libraries to select certain collections of contents in preference to others.

It would seem that Davis[71] was right to say that the organisation of consortia should pay attention to criteria of common interests, rather than geographic proximity, specifically institutional size and the disciplines in which research is performed. The BUCLE consortium, bringing together the universities of the Castile and Leon Autonomous Region, is an example of a grouping on territorial grounds, showing obvious disparities in size and priorities, and as may be inferred from the present study, having different profiles of consumption.

In this research carried out, usage has been the point of focus. The intention is to undertake future investigations into users. This will be achieved by monitoring their behaviour as reflected in transactions in log files and by taking their opinions, gathered through surveys and interviews, which will supply explanations, motivations and awareness of their level of satisfaction, which the less intrusive method based on analysis of log files would not be capable of identifying.

Similarly, it is intended to undertake an analysis of the academic productivity of researchers so as to learn what benefits the availability of a wide range of contents has had for their research work. As was highlighted by Tenopir et al.[72], differences in the consumption of information can be detected between the most productive academics and the rest. It would also seem to be of interest to investigate the parallels and divergences between articles used and articles cited, an aspect studied by Tenopir and King[73]. For this purpose the availability of statistics on articles is essential. It is to be hoped that this greater level of detail in the statistical reports will be attained thanks to the Pirus Project[74].

Appendix A. Supplementary Data

Supplementary data to this article can be found online at doi:10.1016/j.acalib.2011.11.007.

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